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Research report

Lower energy intake following consumption of Hi-oleic and regular peanuts compared with iso-energetic consumption of potato crisps☆

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ABSTRACT

Snack foods can contribute a high proportion of energy intake to the diet. Peanuts are a snack food rich in unsaturated fatty acids, protein and fibre which have demonstrated satiety effects and may reduce total energy intake, despite their high energy density. This study examined the effects of consuming Hi-oleic (oleic acid ~75% of total fatty acids) peanuts and regular peanuts (oleic acid ~50% and higher in poly-unsaturated fatty acids) compared with a high carbohydrate snack (potato crisps) on satiety and subsequent energy intake. Using a triple crossover study design, 24 participants (61 ± 1 years) consumed iso-energetic amounts (56–84 g) of Hi-oleic or regular peanuts or (60–90 g) potato crisps after an overnight fast. Hunger and satiety were assessed at baseline, 30, 60, 120 and 180 minutes following snack consumption using visual analogue scales, after which a cold buffet meal was freely consumed and energy intake measured. The same snack was consumed on 3 subsequent days with energy intake assessed from dietary records. This protocol was repeated weekly with each snack food. Total energy intake was lower following consumption of Hi-oleic and regular peanuts compared with crisps, both acutely during the buffet meal (–21%; $p < .001$ and –17%; $p < .01$) and over the 4 days (–11%; $p < .001$ and –9%; $p < .01$). Despite these reductions in energy intake, no differences in perceived satiety were observed. The findings suggest peanuts may be a preferred snack food to include in the diet for maintaining a healthy weight.

Introduction

Understanding the relationship between snack foods, satiety and energy balance is important as snacks are being consumed in growing amounts (Astrup, Nackenhorst, Bovy, & Popova, 2006; Piernas & Popkin, 2010). Previous research has indicated that snacking, particularly on highly processed foods, may contribute to higher intakes of energy, which in turn could lead to obesity (Bes-Rastrollo et al., 2010). Epidemiological studies have reported lower rates of obesity and diabetes with higher consumption of nuts (Mozaffarian, Hao, Rimm, Willett, & Hu, 2011; Zizza, Siega-Riz, & Popkin, 2001). However, the effects of nuts on these measures are yet to be clarified in randomised controlled trials.

Current evidence indicates that acute consumption of peanuts and tree nuts can suppress appetite. Ground walnuts (48 g), peanuts or peanut butter (43 g), almonds or almond butter (43 g) added to breakfast meals have been shown to increase satiety compared with control breakfasts (Brennan, Mantzoros, Sweeney, & Liu, 2010; Mori, Considine, & Mattes, 2011; Reis et al., 2013). In the walnut study, the protein content of the walnut breakfast was three times higher and the fibre was one and a half times higher than the control breakfast which may account for the increased satiety. The control breakfasts in the peanut and almond studies were not energy matched, making conclusions more difficult to draw. Energy intake is a primary determinant of satiety, as demonstrated by Alper and Mattes (Alper & Mattes, 2002), indicating that test foods and diets need to be energy matched with controls.

The extant research on the satiating effects of nuts has been largely limited to either comparisons with other nut products or

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comparing the addition of nuts to a meal or an ad libitum diet (Brennan et al., 2010; Burton-Freeman, Davis, & Schneeman, 2004; Casas-Agustench et al., 2009; Cassady, Hollis, Fulford, Considine, & Mattes, 2009; Devitt et al., 2011; Kendall et al., 2011; Kirkmeyer & Mattes, 2000; Mori et al., 2011). Moreover, not all studies have demonstrated satiety benefits, with nut consumption (Burton-Freeman et al., 2004; Casas-Agustench et al., 2009; Devitt et al., 2011; Johnston, Trier, & Fleming, 2013) likely reflecting differences in study design and complexities of the satiety response. Few studies have compared the effects of nut consumption relative to consumption of other known popular snacks. A recent randomised crossover trial using a sample of 15 young adults, average age 28 years, unexpectedly demonstrated that acute consumption of a grain snack bar increased satiety compared with iso-energetic consumption of peanuts (Johnston et al., 2013). Short term satiety effects of the snack bar were attributed to its high glycaemic load, whereas the low glycaemic response of the peanuts may have elicited a delayed satiety response which was not measured. Comparison of three iso-energetic snack foods (42 g hazelnuts, 50 g potato crisps or 50 g chocolate) added to an ad libitum diet (control) for 12 weeks did not elicit differences in total energy intake, indicating that all three test foods demonstrated satiating properties (Tey, Brown, Gray, Chisholm, & Delahunty, 2012). Other studies have demonstrated reduced energy intake with nut consumption despite their high fat and energy content (Alper & Mattes, 2002). Although epidemiological evidence demonstrates nut consumption is associated with lower body weight (Bes-Rastrollo et al., 2009), intervention trials measuring energy intake indicate conflicting findings.

The purpose of this study was to compare the effects of eating iso-energetic snack foods, viz. unsalted peanuts and low salt potato crisps, on appetite and subsequent energy intake. We hypothesised that participants would be more satiated after consumption of peanuts which are high in protein, fibre and unsaturated fat compared with potato crisps (low in protein and fibre, high in carbohydrate and saturated fat) and hence their energy consumption would be reduced. The satiating properties of protein and fibre have been demonstrated in several studies (Bowen, Noakes, & Clifton, 2006; Slavin & Green, 2007). Polyunsaturated fatty acids (PUFA) and monounsaturated fatty acids (MUFA) may also be more satiating than saturated fats due to their higher rates of oxidation (Lawton, Delargy, Brockman, Smith, & Blundell, 2000); however, the role of fatty acids on satiety remains unclear (Casas-Agustench et al., 2009).

Two varieties of peanut with differing proportions of monounsaturated fat were used for this comparison. The effects of high-oleic peanuts on appetite have not been evaluated and to our knowledge no studies have previously measured acute satiety effects of peanuts compared with another savoury snack food. Most nut satiety studies have used young populations; however, the prevalence of overweight and obesity is highest in males over 40 years and females over 60 years in the United States (Flegal, Carroll, Kit, & Ogden, 2012). For this reason, an older overweight/obese group was chosen for the present study. The potential of peanuts to contribute to long term satiety and consequent dietary changes would be valuable in light of health risks associated with obesity.

Participants and methods

Participants

Twenty-five healthy participants were recruited from July to September 2011 through newspaper advertisements, flyers and word of mouth. The inclusion criteria were healthy males or post-menopausal females (to avoid influences of hormonal cycles on appetite), aged between 50 and 75 years, non-smokers, BMI ≥ 25 kg/m^2 with self-reported stable weight. Exclusion criteria included restrained eaters as determined by a score of ≤12 for The Three Factor Eating Questionnaire (Stunkard & Messick, 1985). This questionnaire provides scores for measures of cognitive restraint of eating, disinhibition of eating and hunger and has been validated (Allison, Kalinsky, Gorman, & Butcher, 1992). A score of >12 (out of 21) for restrained eating indicates a tendency to restrict food intake in order to control body weight. Other exclusion criteria included current smokers, regular nut consumers, self-reported consumption of ≥1 handful of nuts per week, cardiovascular disease, diabetes, a thyroid condition or a nut allergy. The study was approved by the University of South Australia Human Research Ethics Committee and all participants provided written informed consent prior to participation. The study was registered with the Australian and New Zealand Clinical Trials Registry (ANZCTR N^0 12611001072909).

Test products

Roasted, unsalted Hi-oleic (cultivar Middleton) and roasted, unsalted regular (cultivar Streeton, normal oleic variety closely related to cultivar Middleton) peanuts with skins were provided in 28 g sealed portions by the Peanut Company of Australia (Kingaroy, Queensland, Australia). Unsalted potato crisps (Freedom Foods® 'No Salt' potato crisps, 100 g size) were purchased from a local supermarket as the control food. These food products were stored at room temperature in dark, low humidity conditions. Unsalted potato crisps were chosen as they are similar in energy density (23 kJ/g) and sodium content but lower in protein and fibre content compared with the peanuts (24 kJ/g). See Table 1 for nutrient profile of test foods.

Study protocol

The study used a 3 way randomised crossover design to compare the effects of eating Hi-oleic peanuts and regular peanuts with an alternative snack food (low salt potato crisps) on satiety and subsequent energy intake. During each of the three experimental visits, participants attended the Nutritional Physiology Research Centre at The University of South Australia after an overnight fast of at least 12 hours. On arrival participants were asked to complete visual analogue scales (VAS) for assessment of appetite and satiety (t = −15 min). Participants were randomised to a treatment order using computer generated software (www.randomization.com). At t = 0 min, participants were provided one of three snacks estimated as 15%–20% of daily energy intake based on typical energy intake from a previous study in our research centre with a similar population group (Crichton, Murphy, & Bryan, 2010). Females received 56 g of roasted unsalted Hi-oleic peanuts or roasted unsalted regular peanuts or 60 g of low salt potato crisps, males received 84 g of peanuts or 90 g of the potato crisps. Participants were asked to consume the snack over 10 minutes and were provided with a small amount of water to drink. At t = 30, 60, 120 and 180 min VAS

Table 1
Nutrient profile of test foods (per 100 g).

	Hi-oleic peanuts	Regular peanuts	Potato crisps
Energy (kJ)	2374	2486	2278
Total fat (g)	48	49	36
MUFA (g)	38	24	15
PUFA (g)	3	16	4
SFA (g)	5	7	16
Protein (g)	26	26	6
Carbohydrate (g)	16	16	53
Fibre (g)	9	9	4
Sodium (mg)	16	16	30

MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid (Peanut Company of Australia).